CAJA 1
CARPETA 1

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# HUNDIMIENTO DEL DESTRUCTOR SHEFFIELD

# EN LA GUERRA DE MALVINAS

(Tema de Armas Nucleares a bordo)

<<LINES:00086 PROFU:00031.4  00074.06 ERRORS:0000>»

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de maria laura avignolo.Londres.

Va la historia del sheffield.

Londres, especial,14:

Un informe secreto "desclasificado" la semana pasada en Londres de la "Autoridad
Internacional de Energia Atómica" (IAEA) revela que el destructor británico "Sh
field",hundido durante la guerra de las Malvinas, está en el fondo del Atlánti
co Sur con todas sus cargas nucleares a bordo.

Consternados diputados laboristas interrogaron hoy al primer ministro John Major
en la Camara de los Comunes en la interpelación parlamentaria para saber si el
informe era "verdadero".

El ministro de defensa laborista en las sombras, David Clark explicó a "Clarin"
que "Major se comprometió a dar la respuesta el viernes.Sólo sabemos lo que ha i
nformado ese informe desclasificado que, desde la semana pasada, han enviado a l
a Biblioteca del Parlamento.Pero es una cuestión que nos preocupa profundamente"
dijo.

Clark sostuvo que "de una manera u otra el ministerio de defensa debe aclarar es
ta situación inmediatamente porque el Atlántico Sur es una zona desnuclearizada
historicamente".

UN INFORME SECRETO
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El informe de la IAEA, el organismo internacional que supervisa las instalacione
s de las potencias nucleares,fue desclasificado bajo el nombre de "Inventario de
la basura Radiciativa en el medio ambiente Marino" y fue enviado a la bibliotec
a de la Cmara de los comunes 6 días atrás.

Los grupos de presión "Campaña para el Desarme Nuclear" sostuvo esta tarde que l
as bombas nucleares WE177 del Sheffield en 1982 "estaban dañadas y fueron recupe
rados por buzos de la Marina británica" y trasladadas nuevamente al "Atomics Wea
pons Establishment" en Aldermaston, en el condado de Berkshire.

"El gobierno debe explicar que clase de bombas nucleares iban a bordo,asi hayan
sido retiradas o no ,deben informar si existen peligros de contaminación radicat
iva" dijo Janet Bloomfield, la presidente de la "Campana para el Desarme Nuclear
".

Fuentes del Ministerio de Defensa informaron que las armas nucleares de "task fo
rce naval" británica "fueron removidos antes de que la flota saliera hacia el At
lantico Sur por el miedo a una perdida y ante el hecho de que Argentina no tenia

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armas nucleares".

Una declaración oficial del ministerio de defensa informó:"Como sostuvimos en l
Casa de los Lores y le dejamos claro a la IAEA en ese momento, no hubo nunca n
ngun incidente en el Atlántico Sur envolviendo el poder nuclear británico donde
hubo prdida o dispersión de contaminación radiactiva.Tambien podemos confirmar
ue no hubo prdida y consecuentemente, recuperación de tales armas".

La última palabra del gobierno británico se conocerá el viernes."Si fueron recu
eradas,por lo menos no están fondeadas en el Medio del Atlantico contaminando.
ero toda la información que yo tengo es que la IAEA ha suministrado y sostiene
o contrario a lo que el ministerio de defensa dice" sostuvo el diputado David C
ark ante "Clarín".

Maria Laura Avignolo

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<<LINES:00161 PROFU:00058.8  00139.07 ERRORS:0000>»

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de maria laura avignolo.londres.

va la historia de las respuestas por el asunto del sheffield.

Londres, especial,16:

El gobierno británico informó hoy al Parlamento que la fragata "Sheffield" está hundida a 2000 metros de profundidad a 350 millas al este de las islas Malvinas. Pero respetuoso de su historica política de los tiempos de la guerra fria,se negó a precisar si cargaba o no armas atomicas como habia informado un documento "desclasificado" la semana pasada de la Agencia de Energia Atómica Internacional(AEAI) ,con sede en Viena y depositado en la Biblioteca de la Cámara de los Comunes.

El ministro de las Fuerzas Armadas y nieto de Winston Churchill,Nicholas Soames sostuvo hoy que "como ha sido la práctica de sucesivos gobiernos no confirmamos ni negamos la presencia de armas nucleares en especificos lugares en especificos tiempos.De todas maneras,yo puedo confirmar que Gran Bretaña nunca perdio un arma nuclear y subsecuentemente, no recuperó ninguno" dijo.

Los británicos siempre han temido la presencia de submarinos rusos si precisan el lugar de sus armas nucleares.

SIGUE LA POLEMICA
-----------------------

Las cripticas palabras de Soames tratan de desarticular la polemica sobre el el destructor Sheffield, hundido por la Avión Naval argentina durante la guerra de las Malvinas,cargaba armas nucleares cuando se hundió el 10 de mayo de 1982 en las desnuclearizadas aguas del Atlántico Sur.Según el informe de la AEAAI de 41 paginas al que accedio "Clarín",el Sheffield hundido "en una latitud y longitud desconocida tenia armas nucleares a bordo".Pero su presencia no pudo ser "confirmada" porque el gobierno británico se negó a colaborar con la investigación.

El ministro de defensa laborista en las sombras, David Clark preguntó al gobierno el martes pasado en el parlamento cuál era la verdad sobre este hecho .El premier John Major se comprometió a hacerselo saber el viernes.

Soames,secretario de estado de defensa,fue el encargado de responder a Clark y al laborista Tom Dalyell, que antes habia llevado adelante la investigación sobre el ataque al crucero general Belgrano fuera de la zona de exclusión.

Ante la pregunta de Dalyell de "si se habia adoptado alguna acción o se pensaba adoptarla para remover el material radiactivo de la tumba del Shefffield", Soames contesto con un laconico "no".Pero al requerirsele "el lugar y la profundidad donde el destructor habia sido fondeado",el secretario Soames reveló el secreto.

A 2000 METROS DE PROFUNDIDAD
-----------------------------

"El Sheffield se hundió a unas 350 millas al este de las islas Malvinas, a una profundidad de 2000 metros" dijo en la primera admisión británica del lugar donde se registró el hundimiento.

Otro terminante "no" fue usado por Soames para responder el interrogatorio de David Clark,su contrincante laborista, cuando le preguntó si su ministerio "habia adoptado acciones para recuperar objetos del Sheffield, si contaba con una lista de objetos removidos del destructor antes de ser hundido, si lo haria, si existia alguna clase de monitoreo sobre el Sheffield" y si el "haria un informe". Tambien respondió con un "no" a la pregunta de "cuantas armas nucleares" tenia el Sheffield en el momento de ser hundido.

El secretario Soames explicó las condiciones en las que el destructor habia sido fondeado."El Sheffield fue abandonado cuando se probó que era imposible extinguir el fuego producido por un misil de impacto directo.Fue arrastrada y hundida a los seis dias de haber sido tocada" explicó.

"Durante esos seis dias, los helicpteros trasladaron pequeñas partes para ver si podian ser salvadas y ver que lecciones se podian aprender de eso.Yo entiendo que los únicos armamentos que fueron recuperados eran aparatos de fuego, que habian llegado de otros barcos.No fue hecho ningun esfuerzo para recuperar equipo entonces o subsecuentemente. Como el Sheffield se hundió en aguas muy profundas, no hay forma de monitorearlo o llevar adelante ninguna recuperación" dijo Soames.

RECUPERACION CON BUZOS?
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La "Campana para el Desarme Nuclear"(CND), un grupo de presión vinculado al laborismo,informó el martes en un comunicado que una de las bombas nucleares WE 177 que portaba el Sheffield a bordo fue dañada recuperada por buzos y trasladada al "Atomics Weapons Establishment" en Aldermaston, en el condado de Berkshire.

"El gobierno ha tenido seis años para confirmar o negar las alegaciones de la Agencia Internacional de Energia Atómica.Incluso ha fallado en dar respuesta a las exigencias de información requeridas por la AIEA" dijo Janet Bloomfield, presidente de la CND.

El diputado Tom Dalyell no se mostró conforme con las respuestas del secretario de defensa Nicholas Soames y le proprondrá a su colega David Clarke "concurrir ante la Agencia de Energia Atómica Internacional para dilucidar finalmente el episodio".

"Mi impresión es que a 2000 metros no se puede recuperar nada.Pero yo creo que el Sheffield puede cargar armas nucleares porque se unió a la flota despus que abandonó un ejercicio de la OTAN" dijo el diputado Dalyell a "Clarín" en una entrevista.

LAS COORDENADAS
-----------------

Fuentes navales argentinas explicaron a "Clarin" que "el ataque contra el Sheffiel se produjo en la latitud 52 grados,45 minutos sur y la longitud 57 grados, 15 minutos oestes desde un Super Etendart". Pero ellos tienen registrado que el destructor fue arrastrado por lo menos un dia y medio antes de ser hundido.

"Si está a 2000 metros, está en una fosa . Si cargaba armas nucleares, su santa barbara tiene que estar protegida contra el escape radiactivo.Pero nada se puede hacer a semejante profundidad" explicó un oficial de la marina argentina.

Maria Laura Avignolo

DRAFT

DRAFT5.DOC; July 23, 1991, 9:18 am

IAEA-TECDOC-//

# INVENTORY OF RADIOACTIVE MATERIAL ENTERING THE MARINE ENVIRONMENT :

# ACCIDENTS AND LOSSES AT SEA INVOLVING RADIOACTIVE MATERIAL

A TECHNICAL DOCUMENT ISSUED BY THE

INTERNATIONAL ATOMIC ENERGY AGENCY, 1991

LDC 14/INF. 2
2 September 1991
ENGLISH ONLY

FOURTEENTH CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING OF WASTES AND OTHER MATTER
25 - 29 November 1991
Agenda item 11

IMO

## MATTERS RELATED TO THE DISPOSAL OF RADIOACTIVE WASTES AT SEA

### Inventory of radioactive wastes entering the marine environment

Submitted by the International Atomic Energy Agency (IAEA)

The Consultative Meeting of Contracting Parties to the London Dumping Convention requested the International Atomic Energy Agency (IAEA) to develop an inventory of radioactive wastes entering the marine environment from all sources.

A copy of the draft document entitled "Inventory of Radioactive Material Entering the Marine Environment: Accidents and Losses at Sea involving Radioactive Material" is attached.

The Consultative Meeting is invited to take note of the document and of the efforts of IAEA to complete the series.

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CONFIRMED AND UNCONFIRMED ACCIDENTS AND LOSSES AT SEA

| Date Country | Vessel Involved | Geographical Area | Coordinates Latitude | Coordinates Longitude | Depth m | Description of Nuclear Material Involved | Recovered | Radioactivity Total GBq | Marine Monitoring | Release Occurred |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982.05.10 UK ( unconfirmed ) | HMS Sheffield Surface vessel | South Atlantic ocean Falkland islands | ? S | ? W | ? | Nuclear weapon | ? | ? | ? | ? |
| 1985.05.19 UK ( unconfirmed ) | HMS Resolution Submarine | Atlantic ocean off Florida | ? N | ? W | ? | Polaris missile | ? | ? | ? | ? |

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# ■ PRESS RELEASE ■

FOR IMMEDIATE RELEASE Tuesday 14 May 1996

## HMS Sheffield "WAS carrying nuclear weapons"

The Campaign for Nuclear Disarmament claimed today there was new evidence confirming that HMS Sheffield was carrying nuclear weapons when it was sunk during the Falklands War.

CND said that a document from the International Atomic Energy Authority (IAEA), "Accidents and Losses at Sea involving Radioactive Material", says that the HMS Sheffield WAS carrying nuclear depth charges when it was sunk by an Argentinean Exocet missile in the South Atlantic.

CND also said that it believed one of the nuclear WE-177 bombs on board may have been damaged, was recovered by divers, and brought back to AWE Aldermaston.

CND Chair Janet Bloomfield said today:

"That Britain was equipped to use nuclear weapons in this conflict is absolutely scandalous, and is in flagrant breach of the Plateloco Treaty.

"The Government has had six years to confirm or deny the IAEA's allegations. It has failed even to reply to the IAEA's requests for information.

"The Government now needs to explain what has happened to the nuclear bombs on board, whether or not they have been retrieved, and whether there is any continuing danger of radioactive contamination.

"CND has reason to believe that at least one of the bombs on board may have been damaged, recovered, and brought back to England by ship for repair. The Ministry of Defence should confirm whether or not this is the case."

The IAEA report, published in 1990, is placed in the House of Commons Library this week.

HMS Sheffield had disengaged from a full NATO exercise called 'Spring Train' to link up with the South Atlantic Task Force. The then Defence Minister Jon Nott confirmed that HMS Sheffield was "sailing under wartime orders and with wartime stocks of weapons". However, the Minister of State Lord Trenchard later denied that this meant nuclear weapons were on board: "There is no question but that nuclear weapons are not applicable to the current situation in the Falklands War". But former Navy Minister Keith Speed MP stated shortly afterwards that he "would have been astonished if those ships from exercise Spring Train had not been carrying nuclear weapons".

Janet Bloomfield added:

"The episode of nuclear weapons and the Falklands War underlines yet again the fundamental dangers of nuclear weapons, the environmental hazard they threaten if involved in an accident, and that they are absolutely useless in actual conflict situations." ENDS

For more information contact Eddie Goncalves (Press Officer) on 0171-700 2350.

CND

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Campaign for Nuclear Disarmament

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DRAFT5.DOC; July 23, 1991, 9:18 am

IAEA-TECDOC-//

# INVENTORY OF RADIOACTIVE MATERIAL ENTERING THE MARINE ENVIRONMENT :

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INTERNATIONAL MARITIME
ORGANIZATION

IMO

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2 September 1991
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# 1 FOREWORD

Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter have designated the International Atomic Energy Agency as the competent international authority in technical matters related to sea disposal of radioactive wastes and entrusted it with specific responsibilities.

The Contracting Parties to the Convention requested IAEA to develop an inventory of radioactive materials entering the marine environment from all sources. The rationale for having such an inventory is related to its use as an information base with which the impact of radionuclide sources at sea could be more adequately assessed and compared.

Three sources of anthropogenic radionuclides in the marine environment are considered to be of most relevance in this context: the disposal at sea of low-level solidified radioactive wastes, accidents and losses at sea involving potential releases of radioactive materials and the discharge of low-level radioactive liquid effluents into the marine environment. This report, the second of a series of three, one for each source, provides an inventory of the accidents and losses at sea which may lead to a direct release of radioactive materials into the marine environment. It fulfills specifically the request set up by the Contracting Parties at the Twelfth Consultative Meeting of the London Dumping Convention in 1989.

Other documents recently prepared by the IAEA relevant to the subject of the present document are:

- Low Level Radioactive Waste Disposal: An Evaluation of Reports Comparing Ocean and Land Based Disposal Options, IAEA-TECDOC-562, IAEA, Vienna (1990) and

- Inventory of Radioactive Material Entering the Marine Environment: Sea Disposal of Radioactive Waste, IAEA-TECDOC-588, IAEA, Vienna (1991).

The success of this exercise required the full collaboration of the Contracting Parties. The IAEA would like to thank them for providing the necessary information.

This work was co-ordinated in the Waste Management Section of the Division of Nuclear Fuel Cycle and Waste Management and the responsible officer was D. Calmet.

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## 2 SUMMARY

In 1972, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter designated the IAEA as the competent international authority in matters related to sea disposal of radioactive waste and entrusted it with specific responsibilities. **Inter alia** the Contracting Parties requested the IAEA to develop an **"inventory of radioactive wastes entering the marine environment from all sources"**. The rationale for having such an inventory is related to its use as an information base against which the impact of radioactive materials from disposal operations can be more adequately assessed. The continuous compilation of data on radionuclide sources at sea could also ensure that the IAEA recommendations on the disposal rate in a single basin are not exceeded.

In 1989, in accordance with Article V of the Convention on notification of dumping of vessels in case of **force majeure**, the Contracting Parties agreed to provide all relevant information to the IAEA regarding accidents and losses at sea involving releases of radioactive material. It was decided that this information was to be incorporated in the inventory.

Specific accidents and losses of nuclear material are identified, by country, in Annex I. This information has been confirmed by each country unless specifically noted otherwise.

The inventory shows that, between 1950 to 1991, 31 cases of accidents or losses at sea involving nuclear material were reported in various documents. To date a review of these cases shows that 15 cases have been officially confirmed. Among these, 4 concern the losses of nuclear powered submarines, 4 concern the loss of nuclear weapons, 4 concern the accidents of spacecrafts with nuclear generators, 1 concerns the loss of a cargo of nuclear material and 1 concerns a radiation leak aboard a nuclear propelled surface vessel. The latter two cases and two of the accidents involving spacecraft did not release any radioactivity into the marine environment. For the 11 other cases marine monitoring of the site of accident/loss was performed and on three occasions local radioactive contamination was detected.

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## 3 INTRODUCTION

The Report of the United Nations Conference on Human Environment held in Stockholm in 1972 [1] enunciated general principles for environmental protection. One principle specifically addressed the protection of the marine environment by development of a set of "General Principles for Assessment and Control of Marine Pollution". Pursuant to Recommendation 86 of the Stockholm Conference, these principles were forwarded to an Inter-Governmental Conference held in London in 1972 which adopted the **Convention on the Prevention of Marine Pollution by Dumping**[1] **of Wastes and Other Matter** (referred to as the London Dumping Convention) [2]. The London Dumping Convention (LDC) entered into force on 30 August 1975.

The Contracting Parties to the London Dumping Convention agreed to "promote the effective control of all sources of pollution of the marine environment, and pledge themselves especially to take all practicable steps to prevent the pollution of the sea by the dumping of wastes and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea". Contracting Parties to the London Dumping Convention have designated the IAEA as the competent international authority in matters related to sea disposal of radioactive waste and entrusted IAEA with specific responsibilities. These are:

- to define high level radioactive wastes or other high level radioactive matter **unsuitable** for dumping at sea, as listed in Annex I to the Convention, and
- to recommend a basis for issuing **special permits** for dumping materials listed in Annex II to the Convention.

IAEA was mandated to keep the Definition and Recommendations under review in order to limit the impact of disposal operations. As requested, a provisional definition of high level waste unsuitable for disposal at sea and recommendations were provided in 1974 [3] and successively revised in 1978 [4] and 1986 [5]. The revisions reflect the increasing knowledge of relevant oceanographic behaviour and improving assessment capabilities.

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1 For the purpose of the LDC, "Dumping" means:
(i) any deliberate disposal at sea of wastes and other matter from vessels, aircraft, platforms or other man-made structures at sea;
(ii) any deliberate disposal at sea of vessels, aircraft, platforms or other man-made structure at sea.

Table I: Chronological sequence of major documents published by IAEA in connection with ocean disposal activities.

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1946 First Dumping Operations (USA).

1957 Advisory Group Meeting on Radioactive Waste Disposal into the Sea.

1958 First United Nations Conference on the Law of the Sea (UNCLOS I).

1961 Radioactive Waste Disposal into the Sea. IAEA, Safety Series No 5.

1965 Methods of Surveying and Monitoring Marine Radioactivity. IAEA, Safety Series No 11.

1970 Reference Methods in Marine Radioactivity Studies. IAEA Technical Reports Series No 18.

1972 Terms of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA INFCIR/205.

1974 Provisional Definition of High Level Radioactive Waste Unsuitable for Dumping at Sea and Recommendations. IAEA INFCIRC/205/Add.1.

1975 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter enters into force.

1978 Revised Version of the Definition and Recommendations called for by the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA INFCIRC/205/Add.1/rev.1.

1980 Packaging of Radioactive Wastes for Sea Disposal. IAEA TECDOC No 240.

1981 Considerations Concerning "de minimis" Quantities of Radioactive Waste Suitable for Dumping at Sea Under a Suitable Permit. IAEA TECDOC No 244.

1982 Last Dumping Operation (OECD Countries).

1983 Control of Radioactive Waste Disposal into the Marine Environment. IAEA Safety Series No 61 (Revision of the IAEA Safety Series No 5).

1984 Environmental Assessment Methodologies for Sea Dumping of Radioactive Wastes. IAEA Safety Series No 65.

The Oceanographic and Radiological Basis for the Definition of High Level Wastes Unsuitable for Dumping at Sea. IAEA Safety Series No 66.

1985 Sediment $K_d$s and Concentration Factors for Radionuclides in the Marine Environment. IAEA Technical Reports Series No 247.

1986 An Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea. IAEA Technical Reports Series No 263.

Definition and Recommendations called for by the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA Safety Series No 78.

1988 Assessing the Impact of Deep sea Disposal of Low-level Radioactive Waste on Living Marine Resources. IAEA Technical Reports Series No 288.

1989 Principles for the Establishment of Upper Bounds to Doses to Individuals from Global and Regional Sources. IAEA Safety Series No 92.

1990 Estimation of Radiation Risks at Low Dose. A Report to the Contracting Parties to the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. IAEA TECDOC No 557.

Low Level Radioactive Waste Disposal: An Evaluation of Reports Comparing Ocean and Land Based Disposal Options. IAEA TECDOC No 562.

1991 Inventory of Radioactive Material Entering the Marine Environment, Sea Disposal of Radioactive Waste, IAEA TECDOC No 588.

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To further discharge its responsibilities, the IAEA, regularly issues recommendations and guidance for ensuring that disposal of radioactive wastes into the sea does not result in unacceptable hazards to man and marine organisms (Table I).

Since the entry into force of the London Dumping Convention, States that are Contracting Parties to the Convention have conducted disposal operations in keeping with the relevant IAEA recommendations at a limited number of sites. In 1985, resolution LDC.21(9) of the Contracting Parties to the London Dumping Convention introduced a voluntary moratorium on the disposal of low level radioactive wastes at sea [6]. Since then the IAEA has continued to support the London Dumping Convention by providing scientific advice on issues relevant to the future review of the voluntary moratorium.

The proposal to develop an **inventory of radioactive materials entering the marine environment from all sources** was first raised at the Third Consultative Meeting (1978) [7] of the London Dumping Convention and again in 1985 as part of the studies called for in resolution LDC.21(9) of the Ninth Consultative Meeting. During the Eleventh Consultative Meeting (1988) [8], various Contracting Parties requested the IAEA to work actively towards this objective.

During the Twelfth Consultative Meeting (1989) of the London Dumping Convention the working group on **"the implications of accidents to nuclear-powered vessels"** in accordance with Article V of the Convention on notification of dumping of vessel in case of **force majeure** recommended that "Contracting Parties should be requested to provide all relevant information to the IAEA regarding accidents at sea involving releases of radioactive material". The chairman of the Consultative Meeting "encouraged Contracting Parties to submit information for the compilation of the above-mentioned inventory insofar as this was possible" [9]. It was decided that this information was to be incorporated in the inventory.

The rationale for having such a global inventory is related to its use as an information base against which the impact of all disposals at sea may be more adequately assessed and compared. Among the potential sources of anthropogenic radionuclides in the marine environment, three main sources were selected: the disposal at sea of low level solidified radioactive waste, marine accidents and losses involving radioactive materials and the discharge of low level radioactive liquid effluent. This report, the second of a series which will cover these sources, responds to the latest request of the Contracting Parties and provides the inventory of accidents and other losses at sea that have, might have or will lead to the release of radioactive material into the marine environment.

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Concerning the nuclear accidents, a number of additional Conventions have entered into force: the Convention on Safety of Life at Sea (SOLAS) [10], the Convention on the Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of Nuclear a Accident [11]. Each of these Conventions provides for information dissemination and triggers response mechanisms drawing on existing databases created under related activities such as the IAEA Emergency Response System [12]. In addition, a database has been developed for land and marine transport (1989, Accident and Incident Response System) and a second database is being developed for sealed radioactive sources.

These databases on accidents are promoted by IAEA as useful tools to archive all data on accidents and losses. They may be considered as repositories of information available to all Member States. They are designed to help in reducing the number and consequences of future accidents and losses involving nuclear materials (see Annex II).

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# 4 ANTHROPOGENIC SOURCES OF RADIONUCLIDES IN THE MARINE ENVIRONMENT

## 4.1 INTRODUCTION

The anthropogenic sources of radionuclides found in the marine environment are associated with various human activities, for example:

- the explosion of nuclear weapons either in the atmosphere or during underwater testing,

- the release of low level radioactive liquid effluents from nuclear power plants, reprocessing plants, industries, nuclear propelled vessels, hospitals, scientific research centres and nuclear weapons facilities,

- the disposal on the bottom of the ocean of low level radioactive waste, usually packaged, coming from the installations listed above,

- accidents and losses at sea involving potential releases of radioactive materials into the marine environment, for example the loss of a vessel such as a nuclear powered submarine or one carrying nuclear fuel, or nuclear weapons; the re-entry of a satellite containing nuclear materials; and the loss of sealed industrial sources,

- accidental releases in the atmosphere or in water bodies from nuclear installations on land.

The two sources "Sea Disposal Operations" and "Accidents and losses" are most closely related to the objectives of the London Dumping Convention and the establishment of databases on these sources has been considered a priority. The information available on sea disposal of low level radioactive waste was published as an IAEA TECDOC in 1991 [13].

This report presents the data collected on accidents and losses at sea involving potential releases of radioactive materials into the marine environment. Accidents and losses at sea involving radioactive materials which were removed during recovery operations prior to any radioactivity release were also recorded in order to provide the basic information on these accidents.

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The information on inputs of radionuclides due to atmospheric and underwater nuclear weapons testing is not addressed in this report but is considered in a comprehensive IAEA report on all sources of nuclear materials entering the marine environment. This report is under development and will address the inventory from weapons testing as well as dose estimates [14].

The release of low level radioactive liquid effluents from non military installations is well documented in national reports and will be included in the third database of this series by IAEA. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) periodically reviews the radioactive contamination of the environment due to nuclear power production and to the radioactive fallout associated with past atmospheric nuclear weapon tests. UNSCEAR regularly publishes reports on the "Sources and Effects of Ionizing Radiation" where data on liquid effluent releases and dose assessments associated with these practices, as well as those arising from nuclear explosions, can be found [15, 16, 17]. UNSCEAR documents can be of direct use for comparison of releases at various stages of the nuclear fuel cycle.

Accidents on land which lead to a widespread contamination of the marine environment, such as the Chernobyl accident, were not recorded in this database but will be included in the comprehensive IAEA inventory report cited above. Other smaller-scale accidents or releases on land or directly into freshwater which may eventually lead to contamination of the marine environment are not included in the present report.

Various human activities may, due to accidents or losses at sea, produce direct releases of radionuclides into the marine environment. These sources and applications can be divided into:

- nuclear reactors used for the propulsion of surface ships and submarines;

- nuclear weapons carried aboard surface ships, submarines, aircraft or rockets;

- radioisotope thermoelectric generators (RTG) and nuclear reactors used to generate electricity for spacecraft;

- sealed sources used in marine navigation aids, in engineering, construction, oil and gas prospecting and extraction.

- cargoes of radioactive materials in transit.

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Miscellaneous minor sources (such as depleted uranium used as ballast or alloys with very low radioactive content) which are not considered to be significant in comparison with other potential sources are not included in the present report.

## 4.2 NUCLEAR POWERED CIVILIAN SURFACE SHIPS

Usually to propel nuclear vessels, one or two nuclear reactors are used and are usually of the small pressurized-water type similar to the larger version used in nuclear electric power stations. Since the launch of the first nuclear powered merchant ship in 1959, 9 further civilian nuclear powered vessels have been commissioned [18, 19, 20] (see annex III).

## 4.3 NUCLEAR POWERED NAVY VESSELS

Concerning military vessels, unofficial statistics show that in 1990, on a world-wide basis, there were 575 nuclear powered navy vessels [21]. Of these, it is believed that 510 are submarines and the remaining 65 are surface ships.

## 4.4 NUCLEAR WEAPONS

Nuclear weapons have been designed to be carried out by surface ships, submarines, aircraft, or rockets. To date the loss of these nuclear weapons has been due to failure of the carriers [22].

## 4.5 NUCLEAR POWERED SATELLITES

Nuclear energy is used in some types of spacecraft for generation of heat and electricity. Two types of nuclear energy sources are available, radio-isotope thermoelectric generators (RTG) and nuclear reactors. In RTG's the most commonly used nuclide is plutonium-238 with a half-life of 87.7 years. RTG's have mainly been used by the US. Typical RTG's contain some thousand TeraBecquerels plutonium-238, but advanced types with higher activities are under development. Today they are mainly used for deep space missions.

For higher energy demands nuclear reactors containing enriched uranium ($^{235}U$) are used. Nuclear reactors in spacecraft have mostly been used by the USSR for exemple in some of the Cosmos series of satellites. More than thirty nuclear powered satellites in the Cosmos series have been launched. At the end of the operation time the normal procedure is to boost the reactor to a higher orbit with a lifetime of at least 500 years to allow for the decay of the fission products [22].

### 4.6 CARGOES OF NUCLEAR MATERIALS IN TRANSIT

Transportation by sea of cargoes of nuclear materials is common practice for materials within the nuclear fuel cycle. Packaging design and performance requirements have been defined for the various classes of radioactive materials and recommendations for safe transport have been developed [23]. Nevertheless during storm or collision with an other ship, the cargo can be lost unintentionally or voluntarily dumped into the sea under the clause of force majeure (see Annex II).

### 4.7 SEALED RADIATION SOURCES

Sealed radiation sources are used widely in the marine environment in navigation aids and in association with engineering, construction, oil and gas prospecting and extraction.

Recommendations covering the design of packaging and its use and transportation are subject to appropriate national and international regulations [24]. The IAEA has initiated a project to improve the management of spent sources which will include the creation of an international database (see Annex II).

## 5 ACCIDENTS AND LOSSES AT SEA INVOLVING RADIOACTIVE MATERIAL

### 5.1 THE COMPUTERIZED DATABASE

The rationale for having the inventory is related to its use as an information base against which the impact of radionuclides released into the marine environment can be more adequately assessed and compared. Taking into account these objectives, a management system for the inventory has been developed with capacity for:

- storage of information on past practices,

- inclusion of future information, and

- accessibility of the information needed in impact assessment calculations.

A **computerized database** has been set up with three modules:

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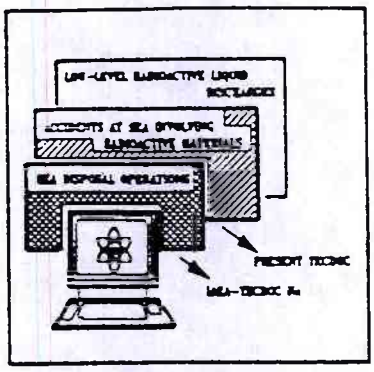

- a module on **Sea Disposal Operations** of packaged low level radioactive wastes,

- a module on **Accidents and Losses at Sea** which may lead to a direct release of radionuclides into the sea,

- a module on **Low Level Radioactive Liquid Releases** from various nuclear installations.

Each database module has been established separately for the storage and rapid retrieval of specific information requested for each source. A system which functions as a memory can be used for radioactive decay correction and used as a source term in calculations such as those on global assessment of the impact of radionuclides released into the marine environment.

5.2 THE MODULE ON ACCIDENTS AND LOSSES AT SEA

Various types of information and data are required for a detailed assessment of a release of radionuclides into the marine environment. In the case of accidents, they include: the quantity, physical state and chemical form and composition of the radioactive source, the characteristics of containment of the source and the oceanographic characteristics of the accident site.

The database module on **Accidents and Losses** is currently designed to provide data only on radioactive sources and contains the following information:

- the date of accident.

- the vessel : Type and navigation flag of the vessel;

- the location : Geographical area, latitude and longitude, and depth of the site of accident;

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- the source : A description of the radioactive material involved in the accident/loss and whether or not the source has been recovered. A value is given for the total amount of radioactivity potentially involved in the accident. It is important to note that this is the total amount involved in the accident, and does not necessarily correspond to the amount actually released into the marine environment. Where the information is available, a detailed inventory for each radionuclide is also included in the database (This information is not included in Annex I). The quantities are expressed in GigaBecquerel on the date of the accident.

- marine monitoring: Where it is known that environmental monitoring was carried out in the marine environment in the vicinity of the accident, this is indicated on the database.

- release occurred: Where there is evidence that radioactive materials have been released into the marine environment this is indicated in the table. A "Yes" entry is given even where the fraction of total inventory released is minimal.

5.3 COLLECTION OF INFORMATION

Pursuant to the recommendations of the Twelfth Consultative Meeting of the London Dumping Convention [9] in 1989, using the information collected from the open literature, IAEA established the provisional database described above on **accidents and losses at sea involving potential releases of radioactive materials into the marine environment**. An extensive literature exists on this subject, but it is recognized that there are inconsistencies in the different sources of information reported (reports, press releases and other unofficial publications: 22, 23, 26, 27, 28).

In January 1990, the IAEA in a circular letter requested Member States to provide information on where accidents have occurred which could have led to potential releases of radioactive materials into the marine environment. To Member

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# 7 ANNEX I

## THE INVENTORY OF ACCIDENTS AT SEA INVOLVING RADIOACTIVE MATERIALS

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## 2 SUMMARY

In 1972, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter designated the IAEA as the competent international authority in matters related to sea disposal of radioactive waste and entrusted it with specific responsibilities. **Inter alia** the Contracting Parties requested the IAEA to develop an **"inventory of radioactive wastes entering the marine environment from all sources"**. The rationale for having such an inventory is related to its use as an information base against which the impact of radioactive materials from disposal operations can be more adequately assessed. The continuous compilation of data on radionuclide sources at sea could also ensure that the IAEA recommendations on the disposal rate in a single basin are not exceeded.

In 1989, in accordance with Article V of the Convention on notification of dumping of vessels in case of **force majeure**, the Contracting Parties agreed to provide all relevant information to the IAEA regarding accidents and losses at sea involving releases of radioactive material. It was decided that this information was to be incorporated in the inventory.

Specific accidents and losses of nuclear material are identified, by country, in Annex I. This information has been confirmed by each country unless specifically noted otherwise.

The inventory shows that, between 1950 to 1991, 31 cases of accidents or losses at sea involving nuclear material were reported in various documents. To date a review of these cases shows that 15 cases have been officially confirmed. Among these, 4 concern the losses of nuclear powered submarines, 4 concern the loss of nuclear weapons, 4 concern the accidents of spacecrafts with nuclear generators, 1 concerns the loss of a cargo of nuclear material and 1 concerns a radiation leak aboard a nuclear propelled surface vessel. The latter two cases and two of the accidents involving spacecraft did not release any radioactivity into the marine environment. For the 11 other cases marine monitoring of the site of accident/loss was performed and on three occasions local radioactive contamination was detected.

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Concerning surface ships, a merchant vessel sank with its cargo of nuclear material which was rapidly recovered before any contamination of the environment occurred. A nuclear propelled ship had a radiation leak of neutrons due to a shielding problem. It involved no release of radioactive material and thus no contamination of the marine environment. For the first accident, radiological surveys on various samples showed no contamination of the marine environment.

Further details of the circumstances in which particular accidents and losses occurred are included in the relevant sections of Annex I.

Sealed radiation sources are commonly used for a variety of purposes in relation to the offshore oil and gas industry (radiography, bore-hole logging) and marine navigation aids. There have been several instances of losses of sealed sources as a result of shipping accidents or damage to installations. These are not included in the database at present (see section 5.3). The packaging and nature of the containment in general, will result in releases taking place over long time scales with the radiological consequences of particular incidents being small.

## 6 CONCLUSIONS AND RECOMMENDATIONS

The review of 15 cases of confirmed accidents and losses show that in 4 cases no release of radioactivity in the marine environment occurred before recovery. In the majority of the remaining cases it has not been possible to verify whether a release occurred. A further 16 cases remain unconfirmed. It has been recognized that deficiencies exist in the database and that certain events and releases, which may result in the contamination of the marine environment, have been excluded. In most cases these will be addressed in other fora. In this context the following recommendations can be made:

- that the database on accidents and losses at sea should be kept under review, that existing entries be revised as needed, and that new entries or categories of data be added as further information becomes available;

- that IAEA Member States should be encouraged to continue to provide additional relevant information on accidents and losses at sea, and in particular to address these entries marked as "unconfirmed" in Annex I;

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Concerning the nuclear accidents, a number of additional Conventions have entered into force: the Convention on Safety of Life at Sea (SOLAS) [10], the Convention on the Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of Nuclear a Accident [11]. Each of these Conventions provides for information dissemination and triggers response mechanisms drawing on existing databases created under related activities such as the IAEA Emergency Response System [12]. In addition, a database has been developed for land and marine transport (1989, Accident and Incident Response System) and a second database is being developed for sealed radioactive sources.

These databases on accidents are promoted by IAEA as useful tools to archive all data on accidents and losses. They may be considered as repositories of information available to all Member States. They are designed to help in reducing the number and consequences of future accidents and losses involving nuclear materials (see Annex II).

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States having had such types of accidents it was requested, in addition, to check the information extracted from the IAEA database. In October 1990 a follow-up letter was addressed to Member States that had not answered the first circular letter.

An Advisory Group Meeting was held in Vienna from June 3-7, 1991 to review the information collected by IAEA at this date and the additional information brought by some of the participants. The new information and corrections received by the secretariat were incorporated into the database.

In relation to sealed sources an additional request has been sent to Member States requesting information on losses at sea to assess the magnitude of this potential source.

All accidents or losses officially notified or confirmed, by Member States, together with reports of accidents for which official confirmation is being sought, are listed in Annex I (Updated to July 1991).

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The information on inputs of radionuclides due to atmospheric and underwater nuclear weapons testing is not addressed in this report but is considered in a comprehensive IAEA report on all sources of nuclear materials entering the marine environment. This report is under development and will address the inventory from weapons testing as well as dose estimates [14].

The release of low level radioactive liquid effluents from non military installations is well documented in national reports and will be included in the third database of this series by IAEA. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) periodically reviews the radioactive contamination of the environment due to nuclear power production and to the radioactive fallout associated with past atmospheric nuclear weapon tests. UNSCEAR regularly publishes reports on the "Sources and Effects of Ionizing Radiation" where data on liquid effluent releases and dose assessments associated with these practices, as well as those arising from nuclear explosions, can be found [15, 16, 17]. UNSCEAR documents can be of direct use for comparison of releases at various stages of the nuclear fuel cycle.

Accidents on land which lead to a widespread contamination of the marine environment, such as the Chernobyl accident, were not recorded in this database but will be included in the comprehensive IAEA inventory report cited above. Other smaller-scale accidents or releases on land or directly into freshwater which may eventually lead to contamination of the marine environment are not included in the present report.

Various human activities may, due to accidents or losses at sea, produce direct releases of radionuclides into the marine environment. These sources and applications can be divided into:

- nuclear reactors used for the propulsion of surface ships and submarines;

- nuclear weapons carried aboard surface ships, submarines, aircraft or rockets;

- radioisotope thermoelectric generators (RTG) and nuclear reactors used to generate electricity for spacecraft;

- sealed sources used in marine navigation aids, in engineering, construction, oil and gas prospecting and extraction.

- cargoes of radioactive materials in transit.

CONFIRMED AND UNCONFIRMED ACCIDENTS AND LOSSES AT SEA

| Date | Country | Vessel Involved | Geographical Area | Coordinates Latitude | Coordinates Longitude | Depth m | Description of Nuclear Material Involved | Recovered | Radioactivity Total GBq | Marine Monitoring | Release Occurred |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984.08.25 | France | Mont Louis Surface vessel | North Sea 20 km off Zeebruges | 51°24,2'N | 002°50,0'E | 25 | Containers cargo Uranium Hexafluoride | Yes | 6000 | Yes | No |



**Mont Louis cargo carrier**

On the 25 August 1984, the French cargo carrier **Mont-Louis** collided with the car-ferry **Olau Britannia**, 20 km off Zeebruges and sank in shallow waters. Among the load of the cargo, 30 containers of less than 1% enriched uranium hexafluoride intended for the USSR were present. The containers were cylindrical, type 48Y, 15 tonnes each. By 4th October, all the containers had been recovered.

Between the 25 August and the 11 October, more than 200 samples of seawater, sand, organisms, air filters and swabs were analyzed and 150 measurements of dose rates were performed by French authorities. None of the analyses revealed any release of radionuclides to have occurred. In addition, no significant dose was registered through different controls performed on the **Mont-Louis** crew members and workers involved in the container recovery [31].

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### 4.6 CARGOES OF NUCLEAR MATERIALS IN TRANSIT

Transportation by sea of cargoes of nuclear materials is common practice for materials within the nuclear fuel cycle. Packaging design and performance requirements have been defined for the various classes of radioactive materials and recommendations for safe transport have been developed [23]. Nevertheless during storm or collision with an other ship, the cargo can be lost unintentionally or voluntarily dumped into the sea under the clause of force majeure (see Annex II).

### 4.7 SEALED RADIATION SOURCES

Sealed radiation sources are used widely in the marine environment in navigation aids and in association with engineering, construction, oil and gas prospecting and extraction.

Recommendations covering the design of packaging and its use and transportation are subject to appropriate national and international regulations [24]. The IAEA has initiated a project to improve the management of spent sources which will include the creation of an international database (see Annex II).

## 5 ACCIDENTS AND LOSSES AT SEA INVOLVING RADIOACTIVE MATERIAL

### 5.1 THE COMPUTERIZED DATABASE

The rationale for having the inventory is related to its use as an information base against which the impact of radionuclides released into the marine environment can be more adequately assessed and compared. Taking into account these objectives, a management system for the inventory has been developed with capacity for:

- storage of information on past practices,

- inclusion of future information, and

- accessibility of the information needed in impact assessment calculations.

**A computerized database** has been set up with three modules:

CONFIRMED AND UNCONFIRMED ACCIDENTS AND LOSSES AT SEA

| Date | Country | Vessel Involved | Geographical Area | Coordinates Latitude | Coordinates Longitude | Depth m | Description of Nuclear Material Involved | Recovered | Radioactivity Total GBq | Marine Monitoring | Release Occurred |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982.05.10 ( unconfirmed ) | UK | HMS Sheffield Surface vessel | South Atlantic ocean Falkland Islands | ? S | ? W | ? | Nuclear weapon | ? | ? | ? | ? |
| 1985.05.19 ( unconfirmed ) | UK | HMS Resolution Submarine | Atlantic ocean off Florida | ? N | ? W | ? | Polaris missile | ? | ? | ? | ? |



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- the source : A description of the radioactive material involved in the accident/loss and whether or not the source has been recovered. A value is given for the total amount of radioactivity potentially involved in the accident. It is important to note that this is the total amount involved in the accident, and does not necessarily correspond to the amount actually released into the marine environment. Where the information is available, a detailed inventory for each radionuclide is also included in the database (This information is not included in Annex I). The quantities are expressed in GigaBecquerel on the date of the accident.

- marine monitoring: Where it is known that environmental monitoring was carried out in the marine environment in the vicinity of the accident, this is indicated on the database.

- release occurred: Where there is evidence that radioactive materials have been released into the marine environment this is indicated in the table. A "Yes" entry is given even where the fraction of total inventory released is minimal.

5.3 COLLECTION OF INFORMATION

Pursuant to the recommendations of the Twelfth Consultative Meeting of the London Dumping Convention [9] in 1989, using the information collected from the open literature, IAEA established the provisional database described above on **accidents and losses at sea involving potential releases of radioactive materials into the marine environment.** An extensive literature exists on this subject, but it is recognized that there are inconsistencies in the different sources of information reported (reports, press releases and other unofficial publications: 22, 23, 26, 27, 28).

In January 1990, the IAEA in a circular letter requested Member States to provide information on where accidents have occurred which could have led to potential releases of radioactive materials into the marine environment. To Member

CONFIRMED AND UNCONFIRMED ACCIDENTS AND LOSSES AT SEA

| Date | Country | Vessel Involved | Geographical Area | Coordinates Latitude | Coordinates Longitude | Depth m | Description of Nuclear Material Involved | Recovered | Radioactivity Total GBq | Marine Monitoring | Release Occurred |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1974.09.01 | Japan | N/V Mutsu Nuclear powered vessel | Pacific ocean 800km E off Shiriyazaki | 41° N | 151° E | - | Shielding problem | - | - | Yes | No |



**N/S Mutsu radiation leak**

On September 1, 1974, during the power raising test in the Pacific ocean a higher than expected leak of radiation was observed on the upper deck of N/S Mutsu caused by neutrons streaming through an annular air gap between the reactor pressure vessel and the primary shield. Repairs were carried out in the Sasebo Shipyard. There was no release of radionuclide into the marine environment. The N/V Mutsu was completed in February 1991 as a "nuclear powered experimental ship" and will be decommissioned, about a year after its complexion, after an experimental voyage [32].

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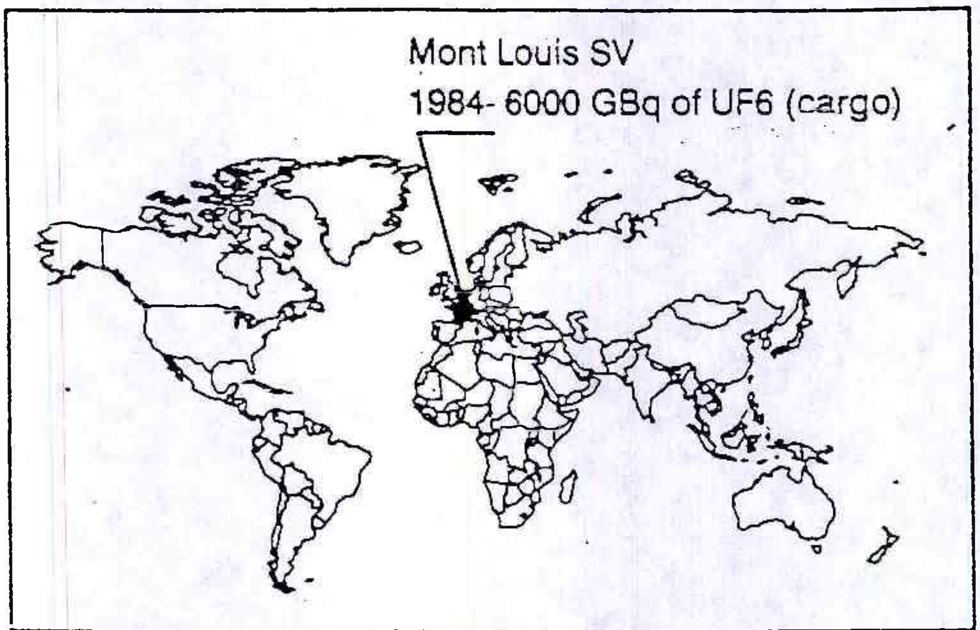
7.1 State: **France**

**Officially confirmed accidents and losses at sea.**

Number of accidents/losses: 1
Number of sites: 1
Number of surface vessels: 1
Number of underwater vessels: 0
Number of aircraft/satellites: 0

Figure A.1: Confirmed accident at sea for France.



CONFIRMED AND UNCONFIRMED ACCIDENTS AND LOSSES AT SEA

| Date | Country | Vessel Involved | Geographical Area | Coordinates Latitude | Coordinates Longitude | Depth m | Description of Nuclear Material Involved | Recovered | Radioactivity Total GBq | Marine Monitoring | Release Occurred |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950.02.13 ( unconfirmed ) | USA | B-36 Bomber | Pacific Ocean off Puget Sound | ? N | ? W | ? | Nuclear weapon | No | ? | ? | ? |
| 1950.11.10 ( unconfirmed ) | USA | Aircraft | Over water, outside USA | ? N | ? E | ? | Nuclear weapons | No | ? | ? | ? |
| 1953.03.18 ( unconfirmed ) | USA | B-36 Bomber | Atlantic ocean off Newfoundland | ? N | ? W | ? | Nuclear weapons | No | ? | ? | ? |
| 1956.03.10 (a) | USA | B-47 Bomber | Mediterranean Sea | ? N | ? E | ? | 2 capsules of nuclear material | No | ? | ? | ? |
| 1958.03.05 ( unconfirmed ) | USA | B-47 Bomber | Atlantic ocean off Georgia | ? N | ? W | ? | 1 nuclear weapon | No | ? | ? | ? |
| mid 1960 ( unconfirmed ) | USA | F-102 fighter aircraft | Pacific ocean Haiphong Bay | ? N | ? E | ? | Nuclear missile | No | ? | ? | ? |
| 1962.06.04 (b) | USA | ICBM Thor Rocket | Pacific Ocean Johnston Island | ? N | ? W | ? | Nuclear test device | No | ? | ? | ? |
| 1962.06.20 ( unconfirmed ) | USA | ICBM Thor Rocket | Pacific Ocean Johnston Island | ? N | ? W | ? | Nuclear test device | No | ? | ? | Yes |
| 1963.04.10 (c) | USA | Submarine SSN-593 Thresher | Atlantic Ocean 100 miles East of Cape Cod | 41°45.0'N | 065°00.0'W | 2590 | Nuclear reactor | No | 1147000 * | Yes | Yes |
| 1964.04.21 (d) | USA | Spacecraft Transit 5BN-3 | West Indian ocean North of Madagascar | ? S | ? E | - | SNAP-9A generator ** | No | 630000 | Yes | Yes |
| 1965.12.05 (e) | USA | Skyhawk Jet A-4E Air craft Carrier CVA-14 Ticonderoga | Pacific Ocean 250 miles South of Kyushu 70 miles East of Okinawa | 27°35.2'N | 131°19.3'E | 4938 | 1 Nuclear weapon | No | ? | Yes | ? |

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- that there should be a continuing review of those activities or events, including accidents and losses in the terrestrial and freshwater environments, which may result in the contamination of the marine environment which have not been considered in recent or on-going IAEA review and information reporting procedures.

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(a) B-47 Bomber, Mediterranean Sea

(to be provided) [34]

(b) ICBM Thor Rocket, Johnston Island

(to be provided)

(c) Nuclear submarine SSN-593 "Thresher"

The USS Thresher was lost in 1963 during deep-sea trials. Investigation revealed that design and construction standards were not as stringent in the non-nuclear part of the ship as in the nuclear propulsion system. It is believed that a leak in a non-nuclear system resulted in loss of the ship. A monitoring survey was carried out but only Cobalt-60 from coolant systems was detected, and only in sediment; no cobalt-60 was detected in water, biota, or the debris area, and there was no evidence of release of radioactivity from the reactor fuel elements. These results confirm that there was no damage to the nuclear reactor either before or after sinking [33].

(d) Transit 5BN-3 (SNAP 9A generator)

On the 21 April 1964 the US navigational satellite Transit 5BN-3 with a SNAP 9A radio-isotope generator containing 630 000 GBq plutonium-238 metal failed to achieve orbit and re-entered the atmosphere at 120 km altitude and burned up over the West Indian Ocean north of Madagascar. The nuclear fuel was vaporized during re-entry and was dispersed worldwide [22, 34].

(e) Skyhawk Jet A-4E, Okinawa

(to be provided)

(f) B-52 Bomber, Palomares, Spain

On January 17, 1966, there was an aviation accident above the town of Palomares (Cuevas de Almanzora) in southeastern Spain. As a consequence of this accident, four thermonuclear bombs carried by one of the planes fell. Two bombs, whose parachutes opened, were recovered intact, one in a dry river bed near the mouth of Almanzora river and the other one in the sea. The two others experienced non-nuclear explosion with some burning and release of the fissile material at impact. Joint effort by the USA and Spain resulted in remedial action and a long-term program to monitor the effectiveness of the cleanup [35, 36].

(g) B-52 Bomber, Thule, Greenland

On January 21, 1968 a B-52 bomber crashed on the ice near the Thule airbase in northern Greenland. The bomber carried 4 nuclear weapons that were destroyed. The radioactive material of the bombs was spread over a large area of the ice. The contamination was mainly confined to the marine environment where it has been estimated that the releases of $^{239,240}Pu$ and $^{238}Pu$ were 0.9 - 1.1 TBq and 18.5 GBq respectively. The monitoring survey shows that most of the activity, including Am, is confined to the benthic environment, preferentially located in the sediments and the benthic fauna, within a distance of 50 km from the crash site of the B-52. [37].

(h) Nuclear submarine SSN-583 "Scorpion"

The reasons for loss of the USS Scorpion have not yet been clearly established. However, there is clear evidence that the loss was not related to a reactor failure. A monitoring survey was carried out but only Cobalt-60 from coolant systems was detected, and only in sediment; no cobalt-60 was detected in water, biota, or the debris area, and there was no evidence of release of radioactivity from the reactor fuel elements. These results confirm that there was no damage to the nuclear reactor either before or after sinking [33].

(i) Nimbus B-1 (SNAP 19 generator)

On the 18 May 1968 the US Nimbus B-1 spacecraft containing a SNAP 19 radio-isotope generator did not reach orbit due to a booster failure at launch. The booster was destroyed at an altitude of 30 km and the spacecraft with the generator fell into the Santa Barbara Channel off the coast of California. The fuel capsules containing 1 300 000 GBq plutonium-238 were recovered from 100 m depth [22, 34].

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## 5.4 FEATURES OF THE ACCIDENTS

The information received by the IAEA is heterogeneous due to the different ways in which records on accidents are kept in different countries. Usually an indication of the date of the accident as well as of the location of the site, in geographical coordinates, is given. The type of vessel and radioactive source are usually reported (see Annex I).

It has been confirmed that 4 nuclear propelled submarines have been lost since 1963 at various sites in the Atlantic Ocean. The depth of the sites of the accidents in the deep-sea, below 1500 meters, have not permitted the recovery of the nuclear reactor due to technological difficulties. The airtight steel shell of the reactor vessel is designed to contain contamination from either normal or accidental operating conditions and is expected to limit the amount of radionuclides released into the marine environment. In two instances the number of nuclear weapons associated with these accidents is not known. Radiological surveys on samples of sea water, sediments and deep sea organisms collected near the various sites of past accidents have been carried out. So far, monitoring data has not shown any elevation in the levels of radionuclides above those due to nuclear weapons fallout, except for Cobalt-60 coming from coolant systems which was detected in some sediment samples collected close to the submarine.

A number of nuclear weapons, and nuclear materials used in nuclear weapons, have been lost at sea following the loss of military aircraft and rockets. One nuclear weapon has been recovered, partial recovery has been achieved in some cases, and others were lost at deep-sea sites and at sites for which only approximate coordinates were given.

Four nuclear powered spacecraft have been lost above the sea. Three of these contained radio-isotope thermoelectric generators (RTG) based on plutonium-238. One RTG was vaporized during re-entry causing a worldwide low-level contamination, and two impacted on the sea surface. Of these, one RTG was recovered without release to the environment and the other is still at the bottom of the sea at 6000 m depth. Post re-entry surveys downwind of the re-entry area confirmed that no fuel was released to the atmosphere, but it is not known if any release has occurred to the sea. The fourth satellite, containing an enriched uranium ($^{235}U$) reactor, re-entered the earths atmosphere due to a malfunction. It is probable that the reactor core disintegrated into small fragments and fell into the South Atlantic Ocean.

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(a) Cosmos 1402 (nuclear reactor)

After completion of its mission in late December 1982 the USSR satellite Cosmos 1402 failed to boost its nuclear reactor into a higher orbit. The spacecraft was split into three parts of which one re-entered and burnt up in the atmosphere on 30 December. The second part re-entered on 23 January 1983 over the Indian Ocean and the third part containing the reactor core (fission products were estimated to reach 1 000 000 GBq) re-entered and broke up over the South Atlantic Ocean on 7 February 1983 about 1600 km east of Brazil. It is not known to what extent the reactor core was vaporized during re-entry [22, 34].

(b) Nuclear submarine (name not notified)

In October 1986, a nuclear submarine sank about 1000 km north-east of the Bermudas in the Atlantic ocean. The submarine was submerged when a fire started, followed by an explosion that damaged the hull. After attempting for three days to reach port under its own power the submersible was towed by a soviet merchant ship before it sank at a depth of 5 000 m [38].

(c) Nuclear submarine "Komsomolets"

On 7 April 1989 in the Norwegian Sea, 180 km south-east of the island Medvezhy, the nuclear submarine "Komsomolets" had an accident and sank. The accident was caused by a fire which started in the stern compartment at 11.02 hours when the submarine was in a submerged position. When the fire started the automatic protection system of the submarine's was triggered. Subsequently the crew shut down the reactor completely. In May 1989 soviet hydrographic ships completed a preliminary survey of the site of the accident. Soviet, Norwegian and British surveys were carried out that showed that the radiation levels at various depths and in sediments samples did not exceed the background level [39].

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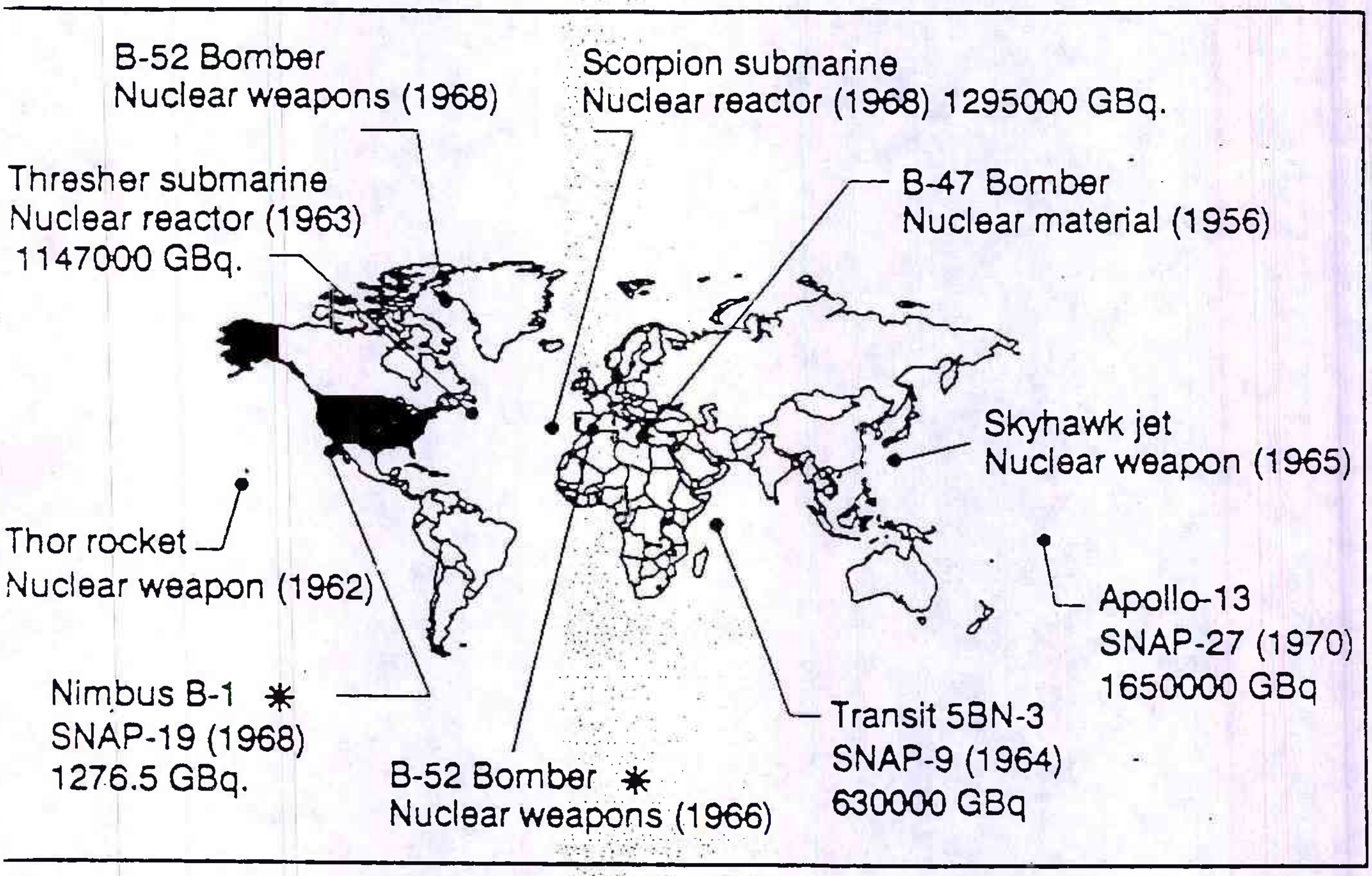
7.4 State: **United States of America**

**Officially confirmed accidents and losses at sea.**

Number of accidents/losses: **10**
Number of sites: **10**
Number of surface vessels: **0**
Number of underwater vessels: **2**
Number of aircraft/rockets/satellites: **8**

Figure A.3: Confirmed accidents/losses at sea for USA.




Key to figure: ✳ : recovered material.
SNAP : Satellite Nuclear Auxillary Power.

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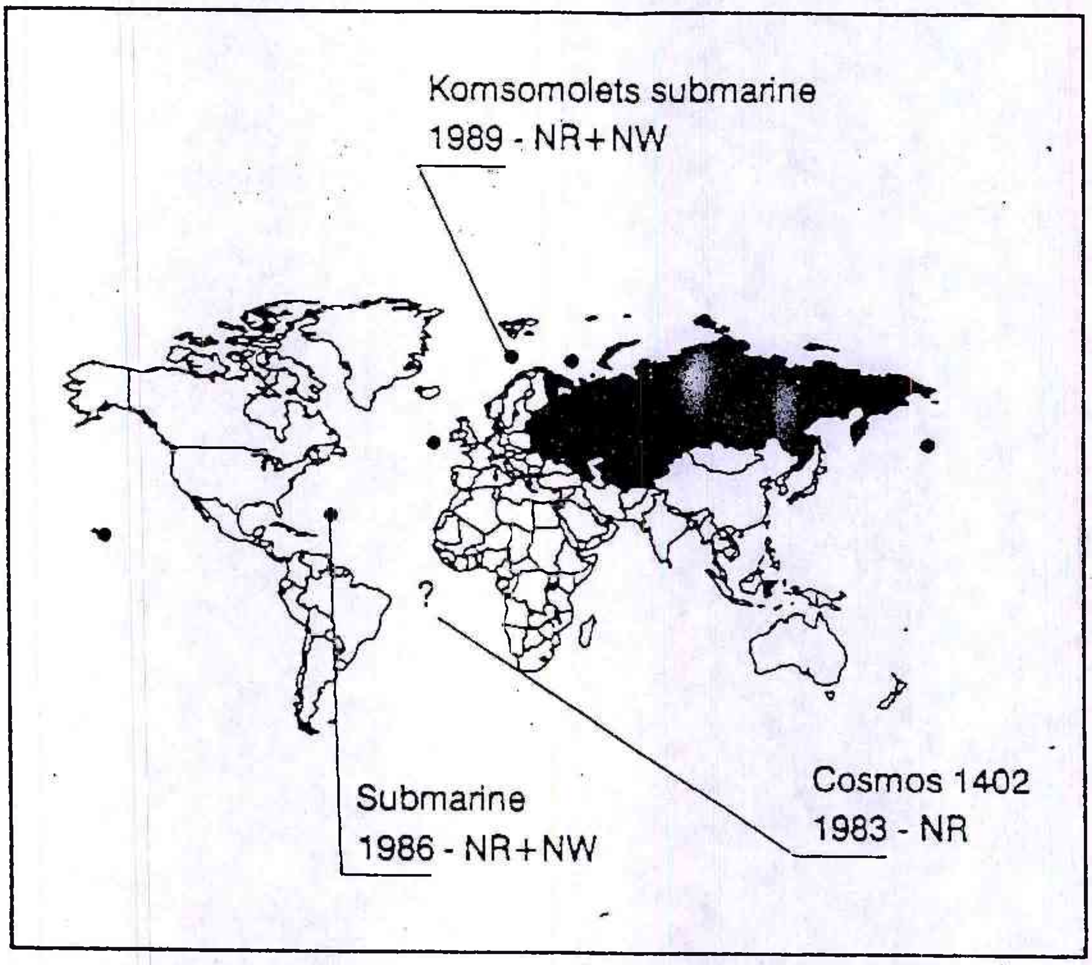
7.5 State: Union of Soviet Socialist Republics

**Officially confirmed accidents and losses at sea.**

Number of accidents/losses: 3
Number of sites: 3
Number of surface vessels: 0
Number of underwater vessels: 2
Number of aircraft/rockets/satellites: 1

Figure A.4: Confirmed accidents/losses at sea for USSR.




**Keys to figure: NR: nuclear reactor, NW: nuclear-weapon.**

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| Date | Country | Vessel Involved | Geographical Area | Coordinates Latitude | Coordinates Longitude | Depth m | Description of Nuclear Material Involved | Recovered | Radioactivity Total GBq | Marine Monitoring | Release Occurred |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968.04.11 ( unconfirmed ) | USSR | Submarine | Pacific Ocean 750 miles NW Oahu Island | ? N | ? E | ? | Reactor core 5 Nuclear weapons | No | ? | ? | ? |
| 1968. ?. ? ( unconfirmed ) | USSR | Submarine | North East Atlantic Ocean | ? N | ? W | ? | Reactor core 4 nuclear weapons | No | ? | ? | ? |
| 1970.01.10 ( unconfirmed ) | USSR | Submarine | Mediterranean sea Bay of Naples | ? N | ? E | ? | nuclear torpedoes | No | ? | ? | ? |
| 1970.04.12 ( unconfirmed ) | USSR | Submarine | North East Atlantic Ocean | ? N | ? E | ? | Reactor core 4 nuclear weapons | No | ? | ? | ? |
| 1974.09.? ( unconfirmed ) | USSR | Kashin-class destroyer | Black sea | ? N | ? E | ? | nuclear weapons | No | ? | ? | ? |
| 1983.06. ? ( unconfirmed ) | USSR | Submarine | North West Pacific Ocean off Kamchatka Peninsula | ? N | ? E | ? | Reactor core 8 nuclear weapons | No | ? | ? | ? |
| 1983.02.07 (a) | USSR | Radar Imaging Satellite Cosmos-1402 | South Atlantic ocean 1600 km East of Brazil | ? S | ? W | - | Reactor core 235U, fission products | No | 1000000 * | ? | Yes |
| 1986.10.04 (b) | USSR | Submarine | Atlantic Ocean Bermudes | 31°29.0'N | 054°42.0'W | 6000 | Reactor core nuclear weapons | No | ? | ? | ? |
| 1989.04.07 (c) | USSR | Submarine Komsomolets | Spitzbergen Medvezhy Isl. 180 km SW Bear Island | 73° ? N | 008° ? W | 1500 | Reactor core Nuclear weapons | No | ? | Yes | ? |

Key to table:

*: estimated

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### AII.1 International Convention for the Safety of Life at Sea

In the 1950s, the development work on nuclear propulsion for seagoing ships started. It was expected that benefit would result from nuclear propulsion's unlimited endurance and independence of fuel supply. In parallel to the development of use of nuclear propelled vessels the members States of IAEA and of the International Maritime Organization (IMO) expressed their concern over the potentially harmful consequences of nuclear accidents on land and at sea. In 1960, an International Convention for the Safety of Life at Sea (SOLAS) was signed in London specifying safety recommendations applicable to nuclear merchant ships [10]. Safety requirements for nuclear ships came under IMO's responsibility in 1974, following a decision by its Maritime Safety Committee. Two years later IMO's subcommittee on ship design and equipment began work on a safety code for nuclear ships. Reflecting as wide a technological base as possible, with inputs from maritime and nuclear experts of several countries, the safety code was drafted and ultimately approved by the Maritime Safety Committee in April 1981 and officially published as the Code of Safety for Nuclear Merchant Ships [29].

### AII.2 Convention on the Early Notification of a Nuclear Accident

Following the Three Mile Island and Chernobyl accidents, there was increased concern about the adequacy of emergency planning and preparedness on the part of the Member States and the IAEA and two international conventions entered into force in 1986: the Convention on the Early Notification of a Nuclear Accident (Early Notification Convention) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention) [11]. The IAEA which is the depository of these conventions, started operating an Emergency Response System (ERS) in 1989 to receive and pass on reported information, including radiological data, to governmental authorities, and to help co-ordinate assistance if required. ERS is supported by the Global Telecommunication System of the World Meteorological Organization (WMO). These Conventions also cover accidents at sea, but to date no nuclear accidents have occurred that required international notification as specified in Article 1 of the Early Notification Convention.

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## AII.3 Computerized database on accidents during transport of radioactive materials

Over the years, a concern has also been expressed regarding the safe transport of radioactive materials. The Member States recommended that IAEA maintain a compilation of transport data in order to use the data as a source of information to help determine the effectiveness of the Transport Regulations and to allow full use to be made of any lesson learned as a result of an accident or incident. Since 1989 an IAEA computerized Database on Events in the Transport of Radioactive Material (EVTRAM) covering all shipments of radioactive materials, has been operating for this purpose [30].

## AII.4 Computerized Database on Sealed Sources

In 1990, the IAEA initiated a project to improve the safe management of spent sources of radiation used in medicine, industry, and other fields. Worldwide, more than half a million sealed radiation sources are estimated to be in commercial use. Under the project's action plan, assistance will be given to help national authorities in identifying, collecting, conditioning, and properly storing spent radiation sources. One of the activity includes assisting Member States in tracking their spent radiation sources inventory by providing an automated standard data base compatible with most personal computer oerating system [24].

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# 9 ANNEX III

## NUCLEAR POWERED CIVILIAN SURFACE SHIPS

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The first nuclear powered merchant ship, the United states' **N/S Savannah** (20 000 SHP/10 000 dwt, passenger/cargo), was launched on 21 July 1959, commissioned on 1 May 1962 and decommissioned in 1970. The next full-scale prototype commercial vessel was the German built **N/S Otto Hahn** commissioned 1968 and decommissioned in 1982. In November 1968, the Japanese began the construction of **N/S Mutsu** (10 000 SHP). The USSR has built various icebreakers, the successful trials of the world's first nuclear powered surface vessel **Lenin** were reported in 1959. It was the prototype of several units of the Arktika class. The most recent soviet icebreakers, the Taymir and Vaygach, belong to a new class of icebreakers produced through a cooperation programme between USSR and Finland [18, 19, 20] (Table AII.1).

Table AII.1 : Civilian nuclear powered vessels.

| Country | Vessel type | Commissioned | Decommissioned |
|---|---|---|---|
| USSR | Icebreakers | | |
| | - Lenin | 1962 | 1990 |
| | - Arktika | 1975 | |
| | - Sibir | 1977 | |
| | - Rossia | 1985 | |
| | - Taymir | 1990 | |
| | - Vaygach | 1990 | |
| | - Sevmorputzi | 1988 | |
| USA | Merchant ship | | |
| | - Savannah | 1962 | 1970 |
| Germany | Commercial vessel | | |
| | - Otto Hahn | 1968 | 1982 |
| Japan | Cargo vessel | | |
| | - Mutsu | 1974 | |

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